

CLAIMS

1. A lithographic projection apparatus comprising:
 - a radiation system which supplies a projection beam of radiation;
 - a first object table constructed and arranged to hold a mask;
 - a second object table constructed and arranged to hold a substrate;
 - an imaging projection system configured to image irradiated portions of the mask onto target portions of the substrate;
 - first and second balance masses disposed along opposite sides of the first object table; and
 - first and second motors configured to move the first object table, each motor having two cooperating electromagnetic members, a first of the members being mounted to the first object table and a second of the members being mounted to at least one of the first and second balance masses,
 - wherein said first and second balance masses are substantially free to move in at least a first direction to provide balancing to the first object table.
2. The apparatus of claim 1, wherein said first direction is substantially parallel to a direction of motion of the first object table.
3. The apparatus of claim 1, wherein said first and second balance masses have parallel planar upper surfaces.
4. The apparatus of claim 3, wherein the first object table is provided with bearings, said bearings being configured to act on said planar surfaces to allow said first object table to move substantially without friction relative to the first and second balance masses.
5. The apparatus of claim 4, wherein said bearings include actuators configured to move said first object table in a direction substantially perpendicular to said first direction and to rotate said first object table relative to at least said first direction.

6. The apparatus of claim 1, further comprises:
a base structure; and
parallel rails coupled to said base structure, said parallel rails having substantially flat horizontal upper surfaces,
wherein said first and second balance masses are supported in a second direction substantially perpendicular to said first direction by a plurality of bearings acting upon said substantially flat horizontal upper surfaces.
7. The apparatus of claim 6, wherein said first and said second balance masses are free to move in said first direction over a relatively wide range of motion.
8. The apparatus of claim 6, wherein said first and second balance masses are free to move in a third direction substantially perpendicular to said first and said second directions, and the movement of said first and second balance masses in the third direction is provided by compliant bearings acting against substantially vertical walls of said parallel rails.
9. The apparatus of claim 6, wherein independent movement of the bearings acting upon the horizontal upper surfaces of the parallel rails provides rotational movement of said first and second balance masses around said first direction and said third direction.
10. The apparatus of claim 6, wherein said bearings have a low stiffness in said second direction such that at least one of said first and said second balance masses is substantially free to move in said second direction.
11. The apparatus of claim 1, wherein a mass of each of said first and second balance masses is 2 to 10 times larger than a mass of said first object table.
12. The apparatus of claim 1, wherein a center of gravity of said first and second balancing masses and a center of gravity of said first object table are located at less than 100 mm apart from each other in a direction perpendicular to said first direction.

13. The apparatus of claim 1, wherein said first object table is driven in said first direction by the first motor acting between the first object table and the first balance mass and by the second motor acting between the first object table and the second balance mass.
14. The apparatus of claim 1, wherein the first and second motors comprise linear motors, armatures mounted to the first object table, and an elongate stator mounted to each of the first and second balance masses.
15. The apparatus of claim 13, wherein said first object table is movable in a direction substantially perpendicular to said first direction by a third motor, and a line of action of said third motor passes through at least a position of a center of gravity of said first object table in the first direction.
16. The apparatus of claim 1, further comprising a drift control which limits drift of the first and second balance masses.
17. The apparatus of claim 16, wherein the drift control comprises a servo control system and an actuator which applies forces to the first and second balance masses biasing a combined center of gravity of the first and second balance masses and the first object table to a desired position.
18. The apparatus of claim 17, wherein the drift control has a servo bandwidth at least a factor of five lower than a lowest resonance frequency of the first and second balance masses and a base of the apparatus.
19. The apparatus of claim 16, wherein the drift control comprises an active system.
20. The apparatus of claim 16, wherein the drift control comprises a negative-feedback servo system.
21. The apparatus of claim 16, wherein the drift control comprises a passive system.

22. The apparatus of claim 16, wherein the drift control comprises at least one spring.
23. The apparatus of claim 1, further comprising a third balance mass having a substantially planar upper surface, wherein said first object table is positioned over said substantially planar surface of said third balance mass.
24. The apparatus of claim 1, further comprising a short stroke frame positioned over said first and said second balance masses and supported by a plurality of bearings.
25. The apparatus of claim 24, wherein said short stroke frame is movable in the first direction and second direction perpendicular to said first direction and rotatable around a third direction perpendicular to said first and said second directions.
26. The apparatus of claim 24, wherein the first object table is driven relative to said short stroke frame to position said mask in six degrees of freedom.